Art. XXIX.—*On the Anatomy of* Hyla aurea.

By George R. Marriner, F.R.M.S., Assistant, Biological Laboratory, Canterbury College.

[*Read before the Philosophical Institute of Canterbury, 6th December,* 1905.]

Plate XLV.

PART I.—VENOUS SYSTEM.

Hyla aurea is the common frog now found in many parts of New Zealand, where it has become plentiful since its introduction from Australia some thirty years ago. As it is one of the types put down for dissection in the University's biological laboratories, a description of its anatomy, illustrated by original drawings, will, I hope, prove acceptable.

The practical books* used in Australasia to-day all describe, as far as I can ascertain, the European form *Rana;* and though I have searched through the Transactions and Proceedings of the learned societies of Australasia, with the exception of Miss Sweet's paper† I have found nothing on the above subject. If *Hyla aurea* corresponded closely in its anatomy to *Rana*, this absence of literature on the former would not be of much consequence; but in many ways, and especially in the veins, the difference is so marked as to make the description of *Rana* more or less useless in a dissection of *Hyla aurea.*

The veins in *Hyla aurea* not only differ from those of *Rana*, but they also vary greatly in the different specimens; and in order to obtain as correct a description as possible some fifty frogs have been dissected, besides many notes have been taken from the specimens used in the biology classes.

The description here appended, though not applicable in detail to every specimen, will, I think, be found correct if a number of frogs be dissected and the most general arrangement of the veins be taken.

The following are some of the more common variations:—

1. The arrangement and size of the veins supplying the skin.

2. The size, number, and direction of the smaller branches of the external jugulars.

3. The size and branching of the lingual veins. (Out of fifteen frogs, five had these veins showing well, but they were

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* "The Frog," A. Milnes Marshall, 6th edition; "Anatomy of the Frog," Ecker (Eng. trans., Haslem). 1889; "Practical Zoology," Parker and Parker; "Atlas of Zoology," Howes.

† "Variation of the Spinal Nerves of *Hyla aurea*," P.R.S. Vic., vol. ix, new series, p. 264.

much thicker than usual; in six they were about normal; and in four they were almost if not quite invisible.)

4. The size, direction, and division of the external jugulars, which may become very much looped along their courses.

5. The division of the subclavian into its two branches. (Out of fifteen frogs, seven had the division near or at the shoulder, six about half-way between the shoulder and the vena cava, and two near the vena cava.)

6. The number of the renal veins. (These seem to vary between five and seven.)

7. The division of the anterior abdominal vein as it breaks up into the lobes of the liver. (Out of fifteen frogs, five had a large branch running into the left lobe, and the other ten had no large branch, but each lobe was supplied by several smaller branches.)

8. The size of the lumbar veins. (Out of fifteen frogs, twelve had them distinct, and in three they were very small.)

9. The size of the ileo-lumbar veins. (In some specimens they were large and distinct, while in others they were very small and indistinct.)

The lumbar and ileo-lumbar veins are often united by a connecting vein. (Out of fifteen frogs, five had a distinct and good connection, in seven a fair connection, and in three there was no connection at all visible.)

Veins from the Skin.

If fig. 1 be compared with Ecker's* it will be seen that the veins coming from the skin differ widely in the two frogs. According to Ecker, with the exception of three pairs of parietal veins near the posterior end of the abdomen, all the blood from the skin is returned through the large cutaneous veins.

Now, in *Hyla aurea* there are four centres from which the blood from the skin is returned, and this is done by four distinct pairs of veins—namely, the external jugulars, the cutaneous, the parietals, and the pelvico-cutaneous—the first three being especially noticeable.

1. The *external jugular veins* (*e.j.*) are a pair of very large and often much-twisted vessels running across the body from the angles of the jaws towards the median line just above the pectoral girdle and then disappearing through the body-wall. Some of their branches—namely, the mandibular and several other large veins—bring in the blood from the skin around the head and shoulders.

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* Ecker's "Anatomy of the Frog," Eng. trans., p. 244, fig. 161.

2. The *cutaneous veins* (*c.*) are a pair of medium-sized vessels bringing blood from the skin for a short distance posterior to the arms. Each vein is composed of a number of small branches, which arise from the skin; they unite and form the large vessel which, after running for a short distance across the ventral body-wall, disappears just below the pectoral girdle.

3. The *parietal veins* (*p.*) are a pair of veins often as large as the cutaneous, and they bring blood from the skin about halfway down the abdomen. They, like the cutaneous veins, are much branched, and the main trunk runs across the ventral body-wall and soon disappears into the body-cavity. Their course as they run to meet the anterior abdominal vein can often be traced through the body-wall.

4. The *pelvico-cutaneous veins* (*p.c.*) are a pair of veins bringing blood in from the skin around the pelvic girdle. Each vein is composed of several branches, and these uniting run through the body-wall near the junction of the legs to the trunk. If the body-wall be opened it will be seen that they connect with the renal portal veins just after the bifurcation of the femoral veins. Near the mid-ventral line and just anterior to the pelvic girdle there are often one or two very small, short veins running out to the skin.

Venous System Proper.

If the ventral body-wall be cut up a little to one side of the middle line, and the flaps laid back after the anterior abdominal vein has been dissected off, the following veins can be seen. Pin the heart back so that the ventricle is pointing towards the snout.

The *sinus venosus* (fig. 2, *s.v.*) is a thin-walled sac lying on the dorsal wall of the heart. It is more or less triangular in shape, and is made up by the union of the posterior vena cava, which enters it from the lower end, and the right and left venæ cavæ, which enter it from the right and left corners respectively.

Veins opening into the Sinus Venosus.

I. *Left Anterior Vena Cava* (fig. 1, *v.c.*).

This is a large, short vein opening into the sinus venosus at its left side, and returns blood from the left side of the head and left fore-limb. It is made up by the union of three veins—namely, the external jugular, the innominate, and subclavian—about 5 mm. from the heart, whence it runs upwards and inwards to the sinus venosus.

Veins that unite to form the Left Anterior Vena Cava.

1. *External Jugular Vein* (figs. 2 and 3, *e.j.*; and fig. 1, *e.j.*).—This is by far the largest and most important vein of the three,

and, beside returning blood from the lower jaw and tongue, it also returns it from the muscles of the shoulder, tympanic membrane, eye, nose, and the left side of the head generally. This latter group of organs is in *Rana** drained by a large branch of the subclavian vein, called the cutaneous, but in *Hyla aurea* the cutaneous (fig. 1, *c.*) does not reach much above the fore-limb.

It may also be noticed that the external jugular is not, as in *Rana*, wholly made up by the mandibular and lingual veins, but these are merely small branches joining on the main vein as it comes from the side of the head. If the skin from the side of the head be dissected off as in fig. 3 the small veins about the head that unite to form the external jugular can be seen.

The nasal vein (fig. 3, *n.*) runs from the external nares, near the edge of the upper jaw, and unites with the main trunk of the external jugular just at the angle of the jaws.

The orbital veins (fig. 3, *o.*) join the nasal as it passes the eye. They are usually two in number.

The tympanic vein (fig. 3, *t.*) is a vein bringing blood from the tympanic membrane.

There is a vein bringing blood from the dorsal muscles of the shoulder, and one bringing blood from the skin around the shoulder and head, which also join the external jugular near the angle of the jaws (fig. 3).

2. *The Innominate Vein* (fig. 2, *in.*).—This is the second and middle vein of the three that make up the left anterior vena cava. It is a very short vein, and is made up of two main branches—(*a*) internal jugular vein (fig. 2, *i.j.*), returning blood from the interior of the skull and the eyeball, and leaving the skull near the posterior border of the orbit; (*b*) subscapular vein (fig. 2, *sa.*) is a smaller vein than the former, and returns blood from the region of the scapular bone.

3. *The Subclavian Vein* (fig. 2, *sub.*).—This is larger than the innominate, but much smaller than the external jugular. It returns blood from the muscles of the shoulder and the fore-limb. It is made up of the (*a*) brachial vein (fig. 1, *br.*), which returns blood from the arm, and, after entering the body-cavity, runs direct to join with the subclavian; (*b*) the musculo-cutaneous vein (fig. 2, *m.* and *c.*, and fig. 1, *c.*) returns blood from the skin posterior to the arms, and some of the muscles of the shoulder. It does not, as in *Rana*, have anything to do with skin anterior to the fore-limbs or the head. The musculo vein returns blood from the muscles, and the cutaneous from the skin, as before described.

* Ecker's "Anatomy of the Frog," p. 244, fig. 161.

II. *Right Anterior Vena Cava.*

This vein and its branches correspond to the left.

III. *Posterior Vena Cava* (fig. 2, *p.v.c.*).

This is a large median vein, returning blood from the kidneys and reproductive organs. It is formed by five or more pairs of renal veins, and then runs forward amongst the viscera, through the liver, on to the sinus venosus. Just after emerging from the liver a pair of hepatic veins join it.

The pulmonary veins are a pair of small veins, and are often very difficult to see. They return blood from the lungs, and run along its inner side to the heart, where they unite, and open into the left auricle.

Portal Systems.

A. *Renal Portal System.*

The large femoral vein (fig. 2, *f.*), which comes up the leg, bifurcates as it enters the body-cavity. The ventral branch forms a portion of the hepatic portal system—namely, the left pelvic vein. The dorsal branch runs along the dorsal body-wall to the lower end of the kidney and joins it on its outer margin. This branch is the left renal portal vein (fig. 2, *r.p.*), and on its way is joined by two smaller veins. The left sciatic vein (fig. 2, *sc.*) brings blood from the back of the thigh, and, coming in from the inner side of the leg, joins the renal portal about half-way between its commencement and its junction with the kidney.

The left ileo-lumbar (fig. 2, *i.l.*) is the name I have given to a medium-sized vein bringing blood from the dorsal body-wall. It commences up near the arms, and runs down more or less parallel with the backbone, and about 10 mm. away from it, until it is near the lower end of the kidney, when it turns in and joins the renal portal just after it leaves the femoral.

The left lumbar vein (fig. 2, *lum.*) is a vein bringing blood from the dorsal body-wall by several branches, and after uniting to form a single vein it joins the renal portal vein about half-way along its length, and on its outer margin.

The right side of the renal portal system is similar to the left.

B. *Hepatic Portal System.*

The anterior abdominal (fig. 1, *a.a.v.*, and fig. 2, *a.a.v.*) is a median vein running on the under-surface of the ventral body-wall from the pelvic girdle to the liver. It is made by the union of the pelvic veins (fig. 2, *pel.*), which are the ventral branches of the femoral veins. It runs forward along the ventral body-wall until over the liver, where it runs down and breaks up into

the liver at the junction of its lobes. On its way it receives the vesical vein (fig. 2, *v.*) from the bladder, also two small veins from the skin above the bladder.

The right parietal vein (fig. 1, *p.*, and fig. 2, *p.*), coming from the skin as before described, runs in at right angles and joins the anterior abdominal vein about half-way along its course.

The hepatic portal vein is rather difficult to see owing to it being obscured by the pancreas, through which it runs. It is made up of gastric vein from the stomach, intestinal and spleenic veins from the intestines and spleen respectively. The two latter form the hepatic portal by uniting at the lower end of the pancreas, and after running towards the liver it is joined by the gastric vein. The hepatic portal then runs on and joins with a large branch of the anterior abdominal vein, the ramus descendens,* which runs down from where the anterior abdominal vein breaks up into the liver for a short distance between the lobes to meet the hepatic portal. Finally it runs into the liver.

PART II.—ARTERIAL SYSTEM.

The arterial system of *Hyla aurea* corresponds pretty closely to that of *Rana*, though there are several differences. Unlike the veins, the arteries do not vary much in the different specimens.

The differences peculiar to the *Hyla aurea* are as follows :—

1. The carotid artery, before running to the head, bends back so as to overlap the systemic arch.

2. The cœliaco-mesenteric artery† (fig. 4, *c.m.*) comes off from the dorsal aorta almost at right angles, while in *Rana* it appears to come off at an angle of 45°.

3. The occipito-vertebral artery (fig. 4, *oc.*) seems to be very different in its divisions from what it is in *Rana*. In the European frog it divides into two branches soon after it leaves the systemic arch. The occipital branch supplies the back and sides of the head, while the vertebral branch runs down the back on the dorsal surface of the transverse processes of the vertebræ. In *Hyla aurea* the occipital branch is much the same as in *Rana*, but I have so far found no vertebral artery, though I have examined many fresh as well as injected specimens. The vertebral artery seems to be replaced in function by several small arteries running from the dorsal aorta and renal arteries. They are short, and supply the muscles, &c., around the vertebral column.

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* "Anatomy of the Frog," Ecker, Eng. trans., 1889, p. 248, fig. 164 (*b*).

† "Anatomy of the Frog," Ecker, Eng. trans., 1889, p. 223, fig. 143 (*j*). "Atlas of Practical Elementary Zootomy," G. B. Howes, 1st ed., pl. iii, fig. xxx (*cœ*).

ARTERIAL SYSTEM OF HYLA AUREA.

The *truncus arteriosus* (fig. 4, *t.*) comes from the ventricle of the heart and divides almost immediately into two main branches. After running for a short distance each half divides into three branches, known as the "aortic arches." (For the sake of simplification, one side only—namely, the left side—will be described.)

A. *Carotid Arch* (fig. 4, *i*).—This is the upper of the three arches, and after running for a short distance it divides into two branches—viz., the lingual artery (fig. 4, *l.*), which comes off just in front of a swelling in the carotid, known as the "carotid gland," and runs forward along the muscles of the lower jaw towards the snout, breaking up into smaller branches as it proceeds; and the carotid artery (fig. 4, *c.*), which runs round the œsophagus, then, after bending backwards so as to overlap the systemic arch, runs forwards and downwards and enters the skull a little to the left of the median line. I have not been able to make out very clearly the course of the carotid artery after it enters the head, but it appears to divide up into internal and external carotids.

B. *Systemic Arch* (fig. 4, *ii*).—This is the middle of the three arches, and runs round and down over the œsophagus to the dorsal body-wall. It then continues on as a large artery and joins with its fellow on the other side, just anterior to the kidneys, to form the dorsal aorta. When opposite the arm this arch gives off two arteries, viz. :—

(*a.*) The occipito-vertebral (fig. 4, *oc.*) : This is seen as a very short, thick artery running downwards and forwards, and disappears into the muscles of the dorsal body-wall. In *Rana* this divides into two branches—namely, the occipital and the vertebral—but in *Hyla* I have only been able to make out the occipital (fig. 4, *oc.*), which runs up to the muscles on the side of the head and also to the orbit.

(*b.*) The subclavian artery (fig. 4, *s.*) branches off from the systemic arch near the origin of the occipital vertebral. It runs out as a large artery to supply the arm.

C. *Pulmo-cutaneous Arch* (fig. 4, *iii*).—This is the third of the aortic arches, and just before it reaches the lung it divides into two, viz. :—

(*a.*) The cutaneous artery (fig. 4, *cu.*) runs outwards and downwards, and disappears in the muscles at the angle of the jaws. It can be traced to the dorsal surface, where it runs as a large vein along the skin from the pectoral down to the pelvic girdle. It has a number of small branches which supply the skin.

(*b.*) The pulmonary artery (fig. 4, *pl.*) bends round and runs down the outer side of the lung, through which it ramifies.

The *dorsal aorta* (fig. 4, *d.a.*), as stated before, is made up by the union of the right and left systemic arches. It runs down close to the vertebral column, and just below the kidneys it divides into the two iliac arteries (fig. 4, *il.*), which supply the legs.

Just where the two systemic arches unite, a large median artery, the cœliaco-mesenteric (fig. 4, *c.m.*), is given off to the viscera. This divides into two smaller arteries—viz. (*a*) Cœliac artery (fig. 4, *cœ.*), which breaks up again into (1) the hepatic artery, running to the gall-bladder and liver, and (2) the gastric artery, supplying the stomach; (*b*) mesenteric artery (fig. 4, *m.*), which breaks up again into (1) the anterior mesenteric, supplying the duodenum and the proximal end of the intestine, and (2) the posterior mesenteric, supplying the distal end.

Just as the iliac artery passes the pelvic girdle it gives off two or three branches that supply the body-wall and some of the muscles of the thigh; these seem to be what Marshall* calls the "lumbar" (fig. 4, *lm.*), and Ecker† the "external iliac arteries."

EXPLANATION OF PLATE XLV.

Fig. 1. Venous system of *Hyla aurea* (enlarged). (Ventral surface with the skin laid back on one side, showing the veins of the skin. Dotted lines indicate the position of the veins that can often be seen through the body-wall.)

e.j. External jugular.
p.c. Pelvico-cutaneous.
p. Parietal.
m. Mandibular.
a.a.v. Anterior abdominal.
c. Cutaneous.

Fig. 2. General view of the venous system of *Hyla aurea* (partly diagrammatic). (Portal systems in black.) (Enlarged.)

s.v. Sinus venosus.
v.c. Left anterior vena cava.
p.v.c. Posterior vena cava.
e.j. External jugular.
in. Innominate.
sub. Subclavian.
l. Lingual.
m. Mandibular.
i.j. Internal jugular.
sa. Subscapular.
br. Brachial.
m. Musculo.
c. Cutaneous.
r. Renal veins.
h. Hepatic.
a.a.v. Anterior abdominal vein.
pel. Pelvic.
f. Femoral.
p. Parietal.
lum. Lumbar.
i.l. Ileo-lumbar.
r.p. Renal portal.
sc. Sciatic.
v. Vesical.
h. Heart.
liv. Liver (diagrammatic).

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* "The Frog," A. Milnes Marshall, 7th ed., p. 31 (*b*, 3).
† "Anatomy of the Frog," Ecker, Eng. trans., 1887, p. 223, fig. 143 (*i*, *e*).

Fig. 3. Side view of the head with the skin laid back, showing the branches of the external jugular veiu.

n. Nasal.
o. Orbital.
t. Tympanic.
e.j. External jugular.

Fig. 4. The arterial system of *Hyla aurea* (partly diagrammatic). (The dotted lines indicate the position of arteries that are hidden by muscles, &c. The carotid artery is made not to overlap the systemic arch, so to avoid confusing the diagram.)

h. Heart.
t. Truncus arteriosus.
i. Carotid arch.
ii. Systemic arch.
iii. Pulmo-cutaneous arch.
l. Lingual artery.
c. Carotid artery.
s. Subclavian artery.
oc. Occipital artery.
o.c. Occipito-vertebral artery.
pl. Pulmonary artery.
cu. Cutaneous artery.
c.m. Cœliaco-mesenteric.
d.a. Dorsal aorta.
il. Iliac artery.
lm. Lumbar artery.
cœ. Cœliac artery.
m. Mesenteric artery.
g. Gastric artery.
r. Renal arteries.
gl. Carotid gland.

Art. XXX.—*Report of some* Crustacea *dredged off the Coast of Auckland.*

By Charles Chilton, M.A., D.Sc., F.L.S., Professor of Biology, Canterbury College, New Zealand.

[*Read before the Philosophical Institute of Canterbury, 6th December,* 1905.]

Shortly after the Dunedin meeting of the Australasian Association for the Advancement of Science, some dredging was done off the coast of Auckland by Messrs. Hedley, Suter, and others. The small number of *Crustacea* that were taken were kindly handed over to me for identification by Mr. H. Suter, and the following report is the result. I have included one or two specimens sent to me later on by Mr. Suter, and some dredged early in 1905 off the Poor Knights Islands by Captain Bollons of the "Hinemoa." Most of the specimens were taken in the Hauraki Gulf at a depth of 25 fathoms, and there were only four taken outside Great Barrier Island in 120 fathoms—viz., a Callianassid, not identifiable; *Lyreidus tridentatus,* De Haan; *Cirolana rossii,* Miers; and *Ampelisca chiltoni,* Stebbing.

None of the species given below are new, though one or two of the *Sphæromidæ,* which I am unable to identify satisfactorily at present, may prove to be new species. There are, however, one or two interesting additions to our knowledge of the distribution of species already known, the most important being that of *Lyreidus tridentatus,* De Haan, which is now recorded from New Zealand for the first time, and belongs to a group of the *Anomura*—the *Raninidea*—hitherto unrepresented in the New Zealand fauna.